Regional Impact of Trade Liberalization on the Income of U.S. Grain/Livestock Farmers

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Estimates of the change in 1970 net farm income resulting from free trade in grains and livestock are derived for ten production regions of the United States. Gains and losses are distributed by six economic classes of farm. Two inequality indices are used to assess the impact on the distribution of income. Although free trade leads to greater inter-regional inequality, intra-regional inequality declines. The net effect is a decline in total inequality. The qualitative relevance of these results under current conditions is supported by their robustness to changes in assumed income gains.

Since the signing of the General Agreement on Tariffs and Trade (GATT) in 1947 the United States has played a major role in an ensuing series of multilateral trade negotiations. In the sixth session, the Kennedy Round (1964-67), agricultural trade emerged as a major area of conflict, with the United States and the European Community (EC) adopting radically different negotiating positions. The U.S. pressed for a significant reduction in trade restrictions in order to expand the market for its exports. The EC, on the other hand, sought to preserve existing barriers in order to protect its fledgling Common Agricultural Policy. No real compromise was reached and little progress was made in liberalizing agricultural trade.

The postwar international economic system, which had done much to facilitate the multilateral approach of GATT, was seriously weakened in 1971 when the U.S., in response to increasing balance of payments pressures, abandoned dollar convertibility. This action and the following dollar devaluation generated considerable uncertainty and widespread fears of a return to prewar protectionist policies. There was a growing realization that a new round of GATT negotiations was needed to deal with the problem. Government ministers from more than one hundred countries met in Tokyo in September 1973 to draw up a set of aims and objectives and the new round, the Tokyo Round, opened in Geneva shortly after.

Agricultural trade liberalization has been adopted by the U.S. as a major priority in the current negotiations. The U.S. feels that it has most to gain on the agricultural front and has been seeking to secure reductions in tariff and non-tariff barriers, primarily in the EC and Japan, in exchange for similar concessions on industrial products.

At the time when negotiating objectives for the Tokyo Round were being established a major study of the potential gains from trade liberalization for U.S. agriculture was conducted [U.S. Congress]. The 'Flanigan report', as it came to be known, was prepared by the Department of Agriculture at the request of Peter Flanigan who was at that time Assistant to the President for International Economic Affairs. It was originally intended for the private use of those branches of the executive concerned with the upcoming negotiations, including the Office of the President's Special Trade Representative. However, its publication was forced by the late Hubert Humphrey who criticized the content of the study in the Senate [U.S. Congress].

The Flanigan report sought to examine the impact on U.S. agriculture and agricultural

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trade of various degrees of liberalization by the major trading nations. The year 1970 was used as its base and a series of projections made to 1980. One of the policy scenarios examined was the abolition of all trade barriers (other than health regulations); a close approximation to a 'free trade' situation.[1] The study concluded that under this alternative major gains in income would accrue to U.S. agriculture. The balance of payments would also improve since agricultural exports would increase by about $9 billion (1970 values).

Virtually all of the projected increase in exports was derived from the grain/livestock subsector.[2] It was estimated that net farm income (excess of returns over variable costs) would more than double even though producers would no longer receive government price support payments. In the derivation of this result the subsector was treated as an integrated whole [U.S. Congress, p. 10]. Major interrelationships, such as the effect of changing feed costs on livestock production, were taken into account in obtaining projections.

The analysis contained in the Flanigan report provides valuable insight into the aggregate impact of trade liberalization. This paper attempts to extend the analysis by illustrating some of its disaggregative implications. Specifically, data from the report are used to derive estimates of potential gains or losses in farm income for ten U.S. production regions both in total, and by economic class of farm. The impact on the distribution of income within and between regions is then assessed.

Regional Gains and Losses from Trade Liberalization

One of the major problems of using the estimates contained in the Flanigan report is that they are projections. To infer the effects of trade liberalization by economic class of farm would require comparable projections of the number of farms in each class under alternative policies. Since these would prove extremely difficult to obtain, a comparative static approach is adopted using the report's base year of 1970.

Projections of net farm income by commodity under a continuation of base year policies and under free trade from the report are used to compute the *proportionate change* in producer income resulting from free trade. These proportions are applied to actual 1970 income data, also contained in the report, to estimate the impact of introducing free trade in that year given instantaneous adjustment to policy change.

The figures in the second column of Table 1 are derived from the application of the Flanigan proportions (in parentheses) to the net income data in the first column. Government price support payments, which would be foregone under free trade, are contained in the third column and the net gain or loss (the sum of two and three) is in the final column. This result indicates a considerable increase in the income of grain/feed producers, even with the loss of government payments. A major factor is an increase in consumption of animal products as protected markets are opened up, and the parallel increase in demand for feed. The only net losers are milk and egg producers.[3]

The first step in the regional analysis is the use of data in Table 1, in conjunction with production figures for 1970 [U.S. Department of Agriculture], to allocate gains and losses to ten production regions.[4] The proportion of total U.S. production of each commodity in each state was calculated and used to apportion the income change.[5] The

[1]This is alternative III in the report.

[2]More precisely the grain-feed/livestock subsector since soybeans are also included. The shortened version will be used throughout this paper.

[3]For a discussion of the changes in production, prices, and trade flows which create these effects see the Flanigan report [U.S. Congress] especially pages 23-37 and 149-59.

[4]See the appendix for a definition of the regions.

[5]This implies the simplifying assumption that the supply or marginal cost curve for each commodity is the same over the relevant range in all states.

TABLE 1. Estimated Impact of Free Trade on Net farm Income by Commodity (1970)

	Returns Over Variable Costs		Change in Gov't Payments	Net Income Gain/Loss
	Actual	Change with Free Trade		
	million dollars			
Barley	191	+ 115 (.6000)	− 45	+ 70
Corn	2661	+1989 (.7473)	−1228	+ 761
Oats	204	+ 76 (.3725)	0	+ 76
Sorghum	460	+ 354 (.7701)	− 237	+ 117
Soybeans	2970	+2225 (.7490)	0	+2225
Wheat	1006	+ 947 (.9412)	− 871	+ 76
Total Grain/Feed	7492	+5706	−2381	+3325
Beef	1512	+ 442 (.2925)	0	+ 442
Eggs	563	− 160 (.2838)	0	− 160
Milk	1714	− 446 (.2604)	0	− 446
Pork	1880	+ 167 (.0886)	0	+ 167
Poultry	202	+ 21 (.1047)	0	+ 21
Total Livestock and Products	5871	+ 24	0	+ 24
Grand Total	13363	+5730	−2381	+3349

Note: a) Figures in parentheses are proportions derived from the source.
b) All values rounded to the nearest million dollars.

Source: Derived from U.S. Congress, Annex 7, Table 6.

TABLE 2. Estimated Income Gain or Loss by Commodity Group and Region

	Grain/Feed	Livestock	Total
	million dollars		
Northeast	+ 64.5	−113.1	− 48.6
Lake States	+ 337.2	− 69.6	+ 267.6
Corn Belt	+1763.2	+ 88.2	+1851.4
Northern Plains	+ 274.2	+ 84.8	+ 359.0
Appalachian	+ 182.6	− 9.9	+ 172.7
Southeast	+ 122.2	− 17.7	+ 104.5
Delta	+ 390.2	− 0.8	+ 389.4
Southern Plains	+ 94.9	+ 50.1	+ 145.0
Mountain	+ 52.6	+ 45.1	+ 97.7
Pacific	+ 43.4	− 32.2	+ 11.2
Total (48 states)	+3325.0	+ 24.9[a]	+3349.9[a]

[a] Totals differ slightly from those in Table 1 due to the exclusion of Alaska and Hawaii.

resulting quantities were then aggregated and are presented in Table 2. These suggest that only one region, the Northeast, would sustain an overall income loss. The Corn Belt derives the major share of total gains — some 55 percent. Other regions, most notably the Lake States, lose on the livestock side but gain more heavily in grain/feed such that overall, gains offset losses.

The next step is to employ information from the 1969 Census of Agriculture [U.S. Department of Commerce] to distribute gains and losses by economic class of farm.[6] Data were compiled by states on the value of marketings of animals and products or the volume of crop production for the appropriate commodities by economic class of farm. Proportions were derived and employed to distribute gains and losses by state, and these were then aggregated regionally.[7] In order to illustrate the relative impact of free trade, average per farm figures in Table 3 were produced using data on the number of farms in each class in each region [Hottel and Reinsel]. Only commercial farms (census classes Ia through V) are considered since noncommercial farms would experience an insignificant change in average income.

A major difficulty in using census data is that they relate to the year prior to the base year. It is therefore necessary to assume that output proportions in 1969 were not significantly different from those in the following year. A further problem is that a single year's figures could be atypical and therefore misleading. However, Hottel and Reinsel have observed that data derived from the 1969 census are consistent with those of other years.

Table 3 demonstrates that the greatest average gains or losses from free trade in grains and livestock are incurred by farms in classes Ia through III. Interestingly enough, by virtue of a lower significance of dairy and poultry activities, classes IV and V in the Northeast gain even though all farms in the region lose on average. In the Pacific region dairy and poultry losses are concentrated in class Ia which proves to be the sole net loser. As might be expected, in many regions, for example the Lake States and the Corn Belt, the largest gainers or losers are the largest farms, and gains per farm decline on a fairly even basis by farm class. However, there are interesting exceptions. In the Southeast class Ib rather than Ia has the highest average gain. This is because dairy and poultry losses fall more heavily on Ia while gains from soybeans fall more heavily on Ib. In the Southern Plains and Mountain regions gains are markedly skewed towards class Ia due to the influence of large cattle operations.

Impact on the Distribution of Farm Income

Differences in gains and losses between farms are likely to have an impact on the characteristics of the distribution of income. An attempt is therefore made to determine

[6]See the appendix for a definition of the classes.

[7]This implies the simplifying assumption that the supply curve for each commodity is the same over the relevant range across all farms in each state.

TABLE 3. Average Per Farm Income Gain or Loss by Region and Economic Class of Farm

	Ia	Ib	II	III	IV	V	All
	thousand dollars						
Northeast	−3.0	−1.1	−0.7	−0.2	0.2	0.2	−0.4
Lake States	5.8	3.6	1.7	1.0	0.7	0.5	1.2
Corn Belt	13.4	9.3	5.8	3.6	1.8	0.9	4.0
Northern Plains	11.2	3.7	2.0	1.2	0.6	0.3	1.6
Appalachian	4.7	2.9	1.8	1.0	0.4	0.2	0.8
Southeast	1.1	2.1	1.5	1.2	0.6	0.3	1.0
Delta	30.7	10.8	5.7	3.9	1.5	0.6	4.6
Southern Plains	10.2	1.8	1.1	0.7	0.3	0.1	0.8
Mountain	8.7	1.5	0.9	0.5	0.3	0.1	1.0
Pacific	−0.2	0.1	0.3	0.2	0.1	0.0	0.1
All (48 states)	7.9	4.6	2.7	1.7	0.8	0.4	1.9

whether distributional inequality is increased or decreased as a result of free trade.

The measurement of inequality is fraught with problems and there is only sufficient space to comment briefly on some important issues [Sen]. It is generally acknowledged that an acceptable measure should indicate an increase in inequality if income is transferred from poor to rich (the Pigou-Dalton condition). However, due to the fact that alternative measures reflect different underlying welfare functions they display differing sensitivity to such transfers.

One of the most popular devices for measuring inequality is the Lorenz curve and the associated gini ratio. The gini satisfies the Pigou-Dalton condition but its efficiency with grouped data is in doubt [Benson]. Theil's alternative also satisfies the condition and can be aggregated in a simple manner over groups. However, it is more difficult to conceptualize.

Theil's measure derives from the concept of entropy in information theory [Sen; Theil]. Briefly, if an event has the probability x of occurring, the information content h(x) of observing that the event has in fact occurred must be a decreasing function of x. Expressed differently, the more unlikely the event the more useful to know it has actually happened. One formula that satisfies this property is

$$(1) \qquad h(x) = \log \frac{1}{x}$$

When there are n possible events each with a probability x_i $(i=1,n)$, such that $x_i \geq 0$ and $\sum_i^n x_i = 1$, the entropy (expected information content H(x)) of the situation can be viewed as the sum of the information content of each event weighted by the respective probabilities

$$(2) \qquad H(x) = \sum_i^n x_i h(x_i) = \sum_i^n x_i \log \left(\frac{1}{x_i}\right)$$

It is then clear that the closer the n probabilities x_i are to 1/n, the greater the entropy. If x_i is re-interpreted as the share of income going to the i^{th} person, H(x) looks like a measure of equality. It obtains its maximum value of log n when all x_i's take the same value 1/n. Subtracting the entropy H(x) of an income distribution from its maximum value gives an index of inequality (T)

$$(3) \qquad T = \log n - H(x) = \sum_i^n x_i \log n x_i$$

Clearly, under a given set of circumstances the higher the value of the index the greater the inequality and *vice versa*.[8]

A major advantage of this measure is that it can be expanded to allow for the decomposition of inequality between and within regionally grouped data. Thus

$$(4) \qquad T_y = \sum_{r=1}^{R} Y_r \log \frac{NY_r}{N_r} + \sum_{r=1}^{R} Y_r \left[\sum_{i \epsilon S_r} \frac{y_i}{Y_r} \log \frac{N_r y_i}{Y_r} \right]$$

where R = number of regions, N = total number of farms, N_r = number of farms in the r^{th} region (r=1,R), Y_r = income share of the r^{th} region, y_i = income share of the i^{th} farm (i=1,N), and S_r = total set of farms in the r^{th} region.

The first term in (4) measures the inequality in the distribution of total income between regions. The second term measures the aggregate inequality within regions. This is the weighted sum of inequality in each region, where the weights are the regional income shares. The unweighted components of this term can be used to summarize distributional impact on a region-by-region basis.

It could be argued that regional income shares are 'inappropriate' weights for determining aggregate intra-regional inequality

[8]One property of this index is that its upper bound increases with the number of individuals. Theil argues that this is a desirable characteristic on the grounds that inequality should be perceived to be greater in a society of 2 million when one person has all the income than in a society of 2 people under the same circumstance.

since regions with relatively high incomes, for example the Corn Belt, will tend to dominate. Recognizing that this might be unattractive, Theil defined an alternative where the weights in the current application are the regional shares of the number of farms. Thus

$$T_n = \sum_{r=1}^{R} N_r \log \frac{N_r}{Y_r} + \sum_{r=1}^{R} N_r \left[\sum_{i \epsilon S_r} \frac{n_i}{N_r} \log \frac{n_i Y_r}{N_r y_i} \right] \quad (5)$$

where n_i = the 'population' share of the i^{th} farm (reciprocal of the total number of farms).

To apply these measures, actual net income by class of farm in 1970 [Hottel and Reinsel] provided the base situation. Total gains and losses employed in the derivation of Table 3 were added to these figures to give the free trade equivalent.[9] Both sets of data contained negative income figures for class V farms in the Northeast and Pacific regions. Since (4) and (5) are restricted to non-negative income shares, classes IV and V in these regions were aggregated.

A further problem is created by the grouping of farms within regions. In applying inequality measures each individual farm within each economic class must be treated as though it realized the mean income of the class. Inequality within classes is eliminated, the level of total inequality is reduced, and the inequality measures are biased downward. However, on the assumption that the degree of inequality within each group does not change markedly as a result of free trade, the measures are still appropriate indicators of the effects of the change.

The results of the analysis are presented in Table 4. Free trade appears to decrease inequality in the majority of regions. Thus the losses incurred by larger Northeastern farms and the gains realized by smaller farms in that region lead to a decline in the value of both indicators, as do the large, but relatively evenly distributed, gains in the Corn Belt (see Table 3). Only in the Northern Plains, Southern Plains, and Mountain regions, where average gains are heavily concentrated in class Ia, does inequality, as measured by appropriate component of T_y, increase.

For the continental U.S. as a whole both measures indicate an increase in the inequality *between* regions, which is perhaps only to be expected given the uneven geographic distribution of gains and losses. This increase is, however, more than offset by a decline in aggregate inequality *within* regions. The net effect is a decrease in total inequality.

[9]It is assumed that free trade in grains and livestock has an insignificant impact on the income derived from other products.

TABLE 4. Indicators of Distributional Impact

	Theil's Inequality Coefficients			
	T_y		T_n	
	Base	Free Trade	Base	Free Trade
Northeast	0.4567	0.4154	0.5924	0.4987
Lake States	0.3364	0.3125	0.4470	0.3796
Corn Belt	0.3965	0.3450	0.5583	0.4379
Northern Plains	0.3135	0.3224	0.4108	0.3912
Appalachian	0.4178	0.4171	0.4178	0.4155
Southeast	0.8625	0.7632	0.9878	0.8300
Delta	0.7328	0.7089	0.8188	0.7863
Southern Plains	0.7063	0.7146	0.8948	0.8614
Mountain	0.6210	0.6312	1.2502	0.9979
Pacific	0.9460	0.9226	1.8842	1.6824
Between Regions	0.0267	0.0318	0.0258	0.0324
Within Regions	0.5328	0.4919	0.6929	0.6067
Total	0.5594	0.5237	0.7187	0.6391

Relevance of the Results

The impact of free or freer trade on U.S. agriculture is a complex question and the comparative static analysis pursued above provides only limited insight. Many crops, such as cotton, peanuts, and tobacco for which changes in domestic policy might have significant implications, have been excluded. Only regional producer aggregates have been considered. Gains or losses incurred by such groups as processors or consumers have been ignored. The analysis has concentrated on the direct impact on farm income and indirect or 'trickle-down' effects have been neglected. The question of possible changes in factor prices, particularly land, has not been addressed and would clearly require a more sophisticated approach [for example Gardner and Hoover].

Perhaps most significantly, attention has been focused on one particular year and conclusions drawn from a single year's figures can rapidly become outdated. Much has changed since 1970, particularly with respect to government policy. In that year over 75 million acres of cropland were held out of production under government programs [U.S. Department of Agriculture]. Since this land has largely been returned to use, it could be argued that the current relevance of the analysis, especially as it relates to grains, is limited. While it is undeniable that the particular dollar values derived above are no longer appropriate, the direction of change in the distributional equality of farm income which they imply may still be valid.

An attempt was made to determine the sensitivity of the analysis to variations in the magnitude of gains and losses. Gross benefits, defined as change in net income excluding government payments, were reduced for all grain and feed products by increments of 10 percent up to a maximum reduction of 50 percent from those employed above. Livestock gains and losses were held constant and inequality coefficients derived for each regional set of data. Despite the magnitude of these reductions, the direction of change in inter-regional, intra-regional, and total inequality was unaffected. On this basis it is suggested that some confidence can be placed in the qualitative results of the analysis.

Conclusions

The achievement of freer world trade in agricultural products is a continuing concern in international negotiations such as those conducted under the General Agreement on Tariffs and Trade. Freer trade is frequently justified on the grounds of increased efficiency of resource use, but it may also have important distributional implications.

The analysis presented in this paper suggests that free trade in the major grain/livestock products would have a significant impact on the regional distribution of U.S. farm income. Income disparity between regions is likely to increase but the disparity within regions is likely to decline. The overall effect of free trade would probably be to reduce distributional inequality.

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Appendix

A. Composition of the Regions

1. Northeast - Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.
2. Lake States - Michigan, Minnesota, Wisconsin.
3. Corn Belt - Illinois, Indiana, Iowa, Missouri, Ohio.
4. Northern Plains - Kansas, Nebraska, North Dakota, South Dakota.
5. Appalachian - Kentucky, North Carolina, Tennessee, Virginia, West Virginia.
6. Southeast - Alabama, Florida, Georgia, South Carolina.
7. Delta - Arkansas, Louisiana, Mississippi.
8. Southern Plains - Oklahoma, Texas.
9. Mountain - Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming.
10. Pacific - California, Oregon, Washington.

B. Definition of Economic Classes of Farms.

Economic Class	Gross Farm Sales
Ia	$100,000 and over
Ib	$ 40,000 - $99,999
II	$ 20.000 - $39,999
III	$ 10,000 - $19,999
IV	$ 5,000 - $ 9.999
V	$ 2,500 - $ 4,999